

What is claimed is:

1. An apparatus (for producing a metal formed product, comprising:)

5 a holding furnace for holding molten metal;  
a semisolidified metal-producing mechanism provided with a vessel for accommodating a predetermined amount of said molten metal therein, for agitating said molten metal in said vessel to give a predetermined slurry state by using a cooling member to obtain semisolidified metal;

10 a cooling member-restoring mechanism arranged adjacent to said semisolidified metal-producing mechanism, for applying a restoring treatment so that said cooling member has a desired function;

15 a forming mechanism for forming said semisolidified metal to have a predetermined shape; and

an articulated robot capable of transporting said vessel to said holding furnace, said semisolidified metal-producing mechanism, and said forming mechanism, wherein:

20 said articulated robot is arranged to be linearly movable back and forth between said holding furnace and said forming mechanism; and

25 a plurality of sets of said semisolidified metal-producing mechanisms and said cooling member-restoring mechanisms are arranged along a direction of back and forth movement of said articulated robot.

2. The apparatus for producing said metal formed product according to claim 1, wherein:

rails for moving said articulated robot linearly back and forth are arranged between said holding furnace and said forming mechanism; and

said plurality of sets of said semisolidified metal-producing mechanisms and said cooling member-restoring mechanisms are arranged along one side of said rails.

3. The apparatus for producing said metal formed product according to claim 1, further comprising a robot for automatically delivering said cooling member between said semisolidified metal-producing mechanism and said cooling member-restoring mechanism.

4. The apparatus for producing said metal formed product according to claim 1, wherein said cooling member-restoring mechanism includes:

a cooling means for applying a cooling treatment to said cooling member;

a solidified matter-removing means for removing solidified matters adhered to a surface of said cooling member;

a coating means for coating said cooling member with a ceramic material;

a drying means for applying a drying treatment to said cooling member; and

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5 a transport means to which said cooling member is detachably attached and which is capable of gripping and successively transporting said cooling member to said cooling means, said solidified matter-removing means, said coating means, and said drying means.

5. The apparatus for producing said metal formed product according to claim 1, further comprising a vessel-restoring mechanism arranged adjacent to said holding furnace and said semisolidified metal-producing mechanism, for applying a restoring treatment to said vessel so that said vessel has a desired function.

6. The apparatus for producing said metal formed product according to claim 5, wherein said vessel-restoring mechanism includes:

a holding means capable of holding said vessel disengaged from said articulated robot so that its opening is directed obliquely downwardly; and

20 air nozzles and coating nozzles arranged toward said opening of said vessel.

25 7. The apparatus for producing said metal formed product according to claim 6, wherein said vessel-restoring mechanism includes first and second holding means capable of simultaneously arranging two of said vessels.

8. The apparatus for producing said metal formed product according to claim 5, wherein said vessel-restoring mechanism includes a tray member for recovering adhered matters removed from an opening of said vessel.

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9. An apparatus for producing a metal formed product, comprising:

a holding furnace for holding molten metal;

a semisolidified metal-producing mechanism provided with a vessel for accommodating a predetermined amount of said molten metal therein, for agitating said molten metal in said vessel to give a predetermined slurry state to obtain semisolidified metal;

a forming mechanism for forming said semisolidified metal to have a predetermined shape;

a vessel-restoring mechanism arranged adjacent to said holding furnace and said semisolidified metal-producing mechanism, for applying a restoring treatment so that said vessel has a desired function; and

an articulated robot capable of transporting said vessel to said holding furnace, said semisolidified metal-producing mechanism, said forming mechanism, and said vessel-restoring mechanism, wherein:

said vessel-restoring mechanism includes:

a holding means capable of holding said vessel disengaged from said articulated robot so that its opening is directed obliquely downwardly; and

said vessel is designed to have substantially the same opening shape as a shape of an opening of said injection sleeve for introducing said semisolidified metal; and

5 a gripping engaging section, with which a gripping mechanism of said articulated robot is engageable, is provided at only one side surface of said vessel.

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13. The apparatus for producing said metal formed product according to claim 12, wherein:

said gripping engaging section includes a plate-shaped member secured to said one side surface of said vessel; and

said plate-shaped member has two surfaces which are parallel to one another in a depth direction of said vessel, and engaging grooves are formed on said respective surfaces.

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14. An apparatus for producing a metal formed product, comprising:

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a holding furnace for holding molten metal;  
a semisolidified metal-producing mechanism provided with a vessel for accommodating a predetermined amount of said molten metal therein, for agitating said molten metal in said vessel to give a predetermined slurry state to obtain semisolidified metal;

25 a forming mechanism having an injection sleeve for introducing said semisolidified metal thereinto, for forming said semisolidified metal to have a predetermined shape; and an articulated robot capable of transporting said

vessel to said holding furnace, said semisolidified metal-producing mechanism, and said forming mechanism, wherein:

said articulated robot includes a gripping mechanism which is engageable with a gripping engaging section provided at only one side surface of said vessel, and said gripping mechanism is provided with:

a first clamp means for directly gripping said gripping engaging section; and

a second clamp means for gripping said first clamp means gripping said gripping engaging section, integrally with said vessel.

15. The apparatus for producing said metal formed product according to claim 14, wherein:

said gripping engaging section has two surfaces which are parallel to one another in a depth direction of said vessel, and engaging grooves are formed on said respective surfaces;

said first clamp means includes first and second clamp pawls which are displaceable to make approach to one another to make engagement with said engaging grooves so that said gripping engaging section is gripped; and

said second clamp means includes a clamp member for integrally pressing and holding, toward said articulated robot, said first and second clamp pawls gripping said gripping engaging section.

16. An apparatus for producing a metal formed product by introducing solid-liquid co-existing metal into an injection sleeve through an opening of said injection sleeve to produce said metal formed product, said apparatus comprising:

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a guide means which is engageable with said opening by making movement back and forth from a position over said opening of said injection sleeve and which is capable of guiding said solid-liquid co-existing metal to said opening; and

a cover means which is capable of closing said opening by covering said opening of said injection sleeve from an upward position.

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17. The apparatus for producing said metal formed product according to claim 16, wherein said cover means includes:

a cover member for closing said opening;

20 a first actuator for moving said cover member back and forth in a substantially horizontal direction to arrange said cover member at a position over said opening; and

a second actuator for moving said cover member upwardly and downwardly to install said cover member to said opening.

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18. The apparatus for producing said metal formed product according to claim 17, further comprising a positioning and holding means for positioning and holding

said cover member with respect to said opening.

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19. The apparatus for producing said metal formed product according to claim 18, wherein said positioning and holding means includes:

a pin provided for said injection sleeve; and

a hole provided for said cover member, to which said pin is fitted.

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20. The apparatus for producing said metal formed product according to claim 16, wherein said guide means includes:

a sleeve guide having a lower end corresponding to an opening size of said opening, said lower end being constructed to have a narrow width in a diametral direction of said injection sleeve as compared with an upper end; and

an elevator means for moving said sleeve guide upwardly and downwardly so that said lower end is engageable with said opening.

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21. An apparatus for producing a metal formed product by introducing solid-liquid co-existing metal into a forming mechanism to produce said metal formed product, wherein said forming mechanism includes:

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an injection sleeve into which said solid-liquid co-existing metal is introduced through an opening and which communicates with a cavity;



a plunger for charging said solid-liquid co-existing metal in said injection sleeve into said cavity; and

a cooling medium-jetting mechanism for jetting a cooling medium toward said solid-liquid co-existing metal through said opening.

22. The apparatus for producing said metal formed product according to claim 21, wherein said cooling medium-jetting mechanism includes:

a support block which is movable upwardly and downwardly by the aid of an actuator; and

a jetting section which is secured to said support block and to which a plurality of nozzles are installed vertically downwardly.

23. The apparatus for producing said metal formed product according to claim 21, wherein:

said cooling medium-jetting mechanism is provided with a tube; and

said tube has a gripping grip which is provided at a first end, and it has a plurality of nozzles which are provided at a second end.

24. A method for producing a metal formed product, comprising the steps of:

introducing solid-liquid co-existing metal into an injection sleeve through an opening of said injection sleeve

air nozzles and coating nozzles arranged toward said opening of said vessel.

5 10. The apparatus for producing said metal formed product according to claim 9, wherein said vessel-restoring mechanism includes first and second holding means capable of simultaneously arranging two of said vessels.

10 11. The apparatus for producing said metal formed product according to claim 9, wherein said vessel-restoring mechanism includes a tray member for recovering adhered matters removed from said opening of said vessel.

15 12. An apparatus for producing a metal formed product, comprising:

a holding furnace for holding molten metal;

20 a semisolidified metal-producing mechanism provided with a vessel for accommodating a predetermined amount of said molten metal therein, for agitating said molten metal in said vessel to give a predetermined slurry state to obtain semisolidified metal;

a forming mechanism having an injection sleeve for introducing said semisolidified metal thereinto, for forming said semisolidified metal to have a predetermined shape; and

25 an articulated robot capable of transporting said vessel to said holding furnace, said semisolidified metal-producing mechanism, and said forming mechanism, wherein:

which constitutes a forming mechanism;

jetting a cooling medium toward said solid-liquid co-existing metal through said opening; and

charging said solid-liquid co-existing metal in said injection sleeve into a cavity after jetting said cooling medium.

25. A method for producing a metal formed product by gripping a vessel in which solid-liquid co-existing metal is accommodated, with a gripping mechanism of an articulated robot, and introducing said solid-liquid co-existing metal into an opening of an injection sleeve, said method comprising the steps of:

rotating a rotary shaft of said gripping mechanism gripping said vessel to rotate said vessel up to a predetermined angle position; and

selectively operating said articulated robot about its respective axes so that said vessel is tilted about a virtual tilting axis which is different from a rotation center to introduce said solid-liquid co-existing metal in said vessel into said opening.

26. The method for producing said metal formed product according to claim 25, wherein said virtual tilting axis is set in the vicinity of an end of said opening.